New Jersey Geological Survey

Information Circular

Geologic Mapping in New Jersey

What is a geologic map?

Often colorful and visually interesting, geologic maps detail the distribution of sediment and rock formations that lie beneath the Earth's surface. Most of New Jersey has surface deposits which include material laid down by rivers, glaciers, wind, movement of soil and rock on hillslopes, by accumulation in lakes and wetlands, or by the decomposition of underlying bedrock. All of them are less than 5 million years old, and some are as much as 400 feet thick. Beneath the surface deposits lie bedrock formations. In New Jersey, these include the hard, consolidated rocks of the north as well as unconsolidated and semi-consolidated Coastal Plain sediments in the south.

Bedrock formations in northern New Jersey include sedimentary rocks formed by compaction and cementation of sediments from ancient river, lake, and marine deposits; igneous rocks that formed when molten rock cooled and hardened; and lastly, metamorphic rocks formed by intensely heating and compressing sedimentary, igneous, and even other metamorphic rocks. The rocks were then deformed by folding and faulting. The bedrock formations, which range in age from 1 billion to 200 million years old, extend to great depths in the Earth's crust.

The Coastal Plain formations in southern New Jersey include alternating layers of sand, silt, and clay deposited in coastal and marine settings between 90 and 5 million years ago. They thicken seaward to as much as 6,500 feet at Cape May.

New Jersey's long and complex geologic history has produced several hundred different bedrock, Coastal Plain, and surficial formations. Geologic mapping is used to unravel and display the complicated three-dimensional geometric relationships of these formations (fig. 1). Measurements and observations of surface outcrops and exposures are combined with data from wells, test borings, and geophysical surveys to produce the maps. Cross sections are often included to show the subsurface arrangement of the formations. In New Jersey, detailed geologic maps are required because of the state's combination of dense population, numerous industrial and waste-disposal sites, complex geology, and extensive reliance on ground water. To provide this level of detail the N. J. Geological Survey's geologic mapping program is conducted at a scale of 1:24,000 (2,000 feet to the inch).

Why are geologic maps important?

Each of the several hundred formations in New Jersey have distinctive physical and chemical properties. These properties determine the physical extent of aquifers and the chemical quality of the water they yield. They also control how ground water recharges and moves through the aquifers, how contaminants seep into and move through soil and ground water, and where natural hazards like radon, sinkholes, and seismic instability may occur. Finally, these properties establish where geologic resources such as sand, gravel, peat, clay, quarry rock, and mineral ores are located. Geologic properties also determine the suitability of an area for the use of septic systems, the management of stormwater and surface runoff, and the stability of foundations for buildings, bridges, tunnels, and other structures. Geologic maps, as the record of the physical and chemical foundation of the solid earth, are thus important for informed decisions about the use and management of natural resources.

Some recent examples from New Jersey

Since the beginning of the N.J. Geological Survey's quadrangle mapping program in the early 1980's a number of environmental issues have been addressed using geologic maps. Several are described here.

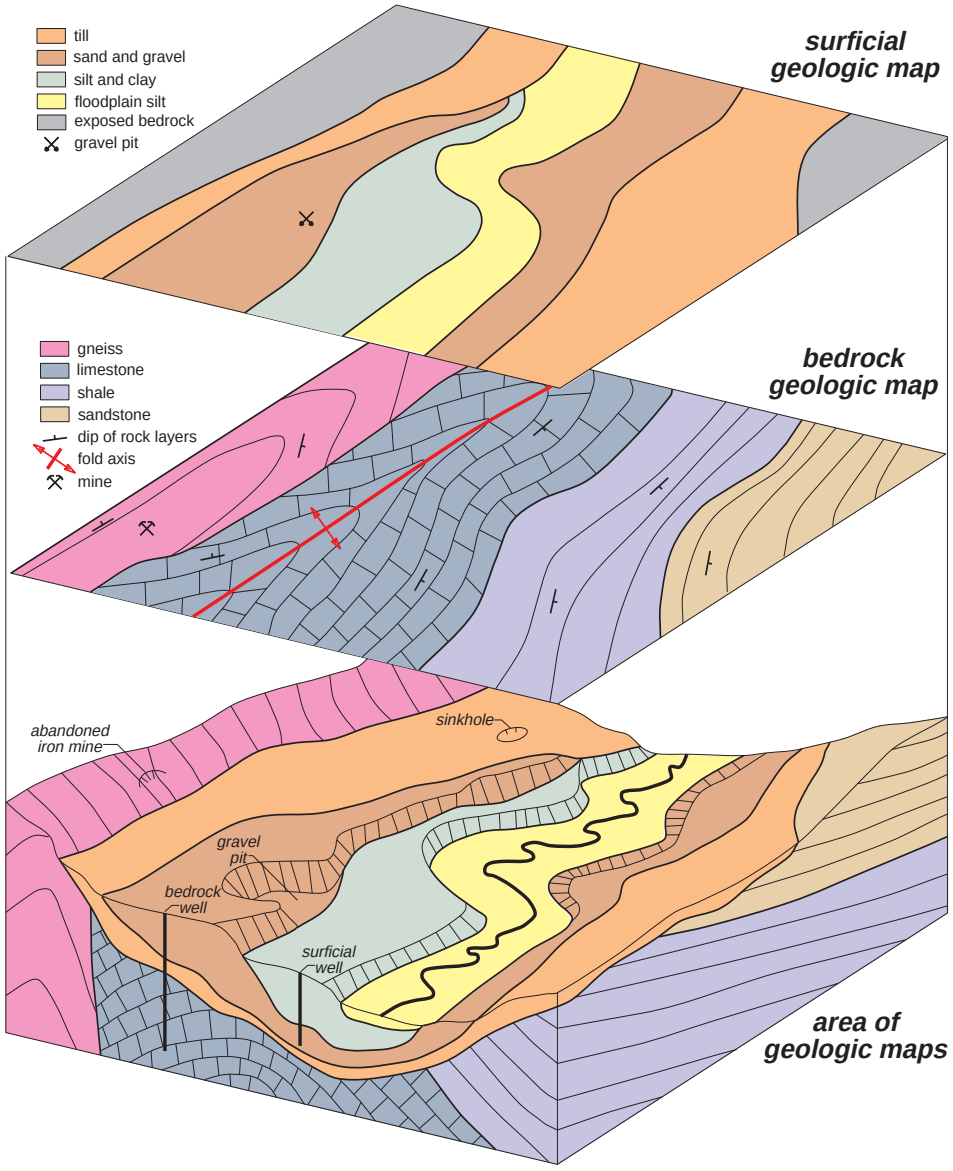

Figure 1. Block diagram (at bottom) illustrating how surficial and bedrock geologic maps (projected above) depict geologic conditions in a typical valley in glaciated northwestern New Jersey. Sand and gravel and limestone are important aquifers. Recharge routes depend on the three-dimensional geometric relationships of the surficial deposits and bedrock formations. Geologic resources such as sand and gravel, and hazards like sinkholes and abandoned mines, are also mapped.

Radon: Radon gas is generated in distinct horizons in rock and sediment with high uranium content. These horizons include certain types of granite, limestone, and shale in northern New Jersey, and several clay layers and boundaries between formations in the Coastal Plain sediments of southern New Jersey. Geologic maps show these horizons and can be used to predict the possible occurrence of elevated radon levels.

Sinkholes: Limestone rock in northwestern New Jersey can be dissolved by ground water, forming underground cavities that may enlarge to create sinkholes at the land surface, damaging structures and roads (fig. 2). The limestone rocks are divided into 19 formations, each of which has a particular tendency to generate sinkholes. Detailed geologic maps show the distribution of these formations, and several municipalities in the limestone belt have used the maps to draft building ordinances to avoid sinkhole damage.

Figure 2. Sinkhole damage in Phillipsburg, NJ. Photo courtesy of Rick Rader.

Aquifer Recharge: Ground water provides over 40 percent of New Jersey's potable water. To preserve this essential resource, the State Legislature directed the N.J. Department of Environmental Protection (DEP) in 1988 to map aquifer recharge areas. This is accomplished by combining geologic map data that show the extent of aquifers and overlying surficial deposits with land use and precipitation data. Together, a recharge capacity rank is established. Permeable geologic materials at the surface that are physically connected with aquifers below act as recharge conduits. Proper aquifer management requires that infiltration of surface water on these permeable outcrops be maintained to ensure aquifer replenishment.

Harbor Dredging: The Port Newark-Port Elizabeth marine terminals account for several billion dollars a year in economic activity. These terminals require shipping channels that are deep enough for ocean-going vessels. The feasibility and cost of the dredging and disposal of channel spoils depend in part on the depth to bedrock and the properties of the overlying sediments. Recently completed geologic mapping in the harbor area, including data from over 1,000 test borings, provides this information. It has been used by the New York-New Jersey Port Authority and the U.S. Army Corps of Engineers to design dredge-spoil disposal pits and estimate dredging costs.

Seismic Hazard: Damaging earthquakes, although rare in New Jersey, are a potential hazard. In addition to an earthquake's intensity, the damage resulting from an earthquake depends on the degree of ground shaking, which in turn depends on the thickness, compaction, and water content of underlying surficial deposits. The N.J. Geological Survey, with funding from the U.S. Geological Survey, the Federal Emergency Management Agency, and the N. J. Office of Emergency Management, has recently completed mapping of these sediments and their properties for the Newark, Jersey City, and Hackensack Meadowlands areas. In these areas, glacial-lake and salt-marsh deposits are particularly vulnerable to seismic shaking. The geologic data, in combination with construction and census information, are analyzed using earthquake simulation software to predict potential damage. These predictions are then used by emergency management agencies to plan disaster response.

Watershed Characterization: The DEP is shifting efforts to manage our water resources from the site-specific regulation of industry and other point sources to a more holistic approach called watershed management. Environmental quality in regions known as watersheds is assessed by monitoring a series of environmental indicators over time. This approach requires a thorough knowledge of natural conditions and how they vary in space and time so that man-made influences can be identified. Geology is an important component of these issues because it determines the natural chemistry of waters and soils, and the natural conditions of runoff, stream flow, and the shallow ground-water flow that feeds water into streams. For example, much of the upland land surface within watersheds in the Highlands, which feed reservoir systems that serve much of northeastern New Jersey, is glacially eroded bedrock outcrop with little or no soil cover. Because there is little soil or sediment to cleanse septic effluent and absorb runoff, these watersheds are particularly susceptible to pollution. Geologic maps show the extent of bedrock outcrop and thin soil cover. This information has been used to guide open-space acquisitions aimed at watershed protection.

Soil Contamination: Elevated levels of trace metals have been measured in soils throughout the state. In many cases these are clearly the result of human activities but in some cases the elevated levels may be natural. The natural occurrences are caused by concentrations of certain minerals in the underlying formations. Geologic maps show the outcrop of these formations and so can be used to distinguish natural and man-made contamination. This information is important for remediation strategy.

Status and goals of geologic mapping in New Jersey

Figure 3 shows the status of 1:24,000-scale surficial and bedrock geologic mapping in New Jersey. Published maps include complete geologic descriptions, cross sections, and supporting data. They are available in one of the following formats: printed, blueprint, or color plotter. Simplified versions of the maps showing the surface outcrop patterns of the geologic formations are being digitized and made available as GIS coverages. Unpublished maps are also available for much of the state by written request to the State Geologist. Since 1993 mapping has been supported by a federal matching grant program administered by the U.S. Geological Survey. Yearly mapping proposals are evaluated and prioritized by an advisory subcommittee within New Jersey. Mapping efforts have focused on urban and suburban areas, and on important aquifers and watersheds, of northern New Jersey and the inner Coastal Plain, where the need for detailed information is greatest. The ultimate goal is to complete 1:24,000 surficial and bedrock maps for all 178 quadrangles covering the state.

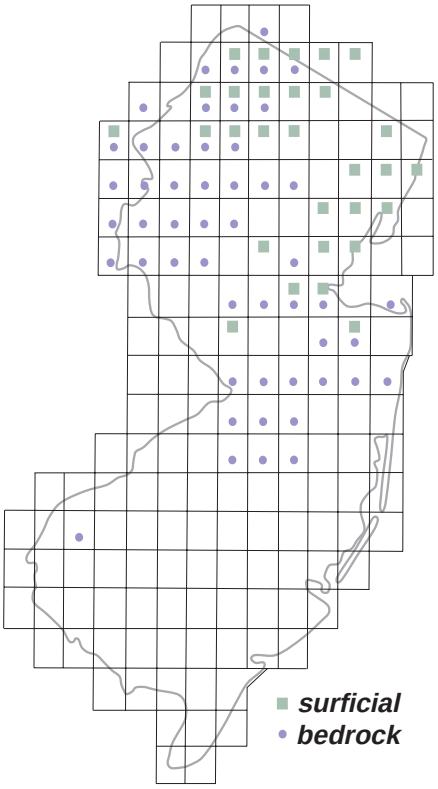

Figure 3. Published 1:24,000-scale surficial and bedrock geologic maps for New Jersey, as of 1998. Contact NJGS for ordering information.

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